SOME AMERICAN SPECIES OF MARSILEA WITH SPECIAL REFERENCE TO THEIR EPIDERMAL AND SORAL CHARACTERS

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In connection with the monographic study of the genus *Marsilea* in India that has been undertaken in my laboratory at Jaswant College, Jodhpur, a loan of about one hundred and fifty sheets of *Marsilea* comprising eleven American species was received from the University of California Herbarium, Berkeley, for comparison with the Indian species. Of the species received, only two, *M. minuta* and *M. quadrifolia,* are represented in the Indian flora. Study of this material led to the paper here presented.

Marsilea is a genus of world-wide distribution. Just as *M. minuta* is of very wide occurrence in India from the Panjab in the north to Travancore in the south, *M. vestita* among the American species has a wide range of distribution throughout the western and Pacific United States and, like the Indian species, is very variable. It has been observed that *M. minuta* possesses varieties which are anatomically distinct, particularly in the internal organization of the sporocarps, but since this subject is now being studied by my research students from both the morphological and cytological point of view, I do not wish to anticipate their results herein. Miss Margaret Stason (1926), too, had hinted toward such a possibility while discussing the possible connection between *M. vestita* and *M. oligospora.* I should like to state that both these latter species seem distinct from one another.

Because the American material was limited in quantity, my study of these species is not as extensive as I would have liked. In some cases it was possible to remove only one or two sporocarps from the herbarium sheets for the study of their internal structures. However, the external characters were carefully studied and in spite of the fact that the genus is notorious for its morphological plasticity, one cannot always ignore certain differences like the shape of the leaflets (figs. 1–9) that might clearly be discernible among the allied species. I have, therefore, summarized these observations on the vegetative characters in Table 1.

On account of the limitations imposed for want of preserved material, I chose to remove only a few leaflets and some sporocarps from each of the collections in order to examine their epidermal and soral characters. It is a well known fact that with the publication of many important works on the epidermal and cuticular studies of vascular plants (Linsbauer, 1898; Porsch, 1905; Thomas and Bancroft, 1913; Rehfous, 1917; Bandulska, 1923, 1926; Prat, 1932; Florin, 1931 and afterwards; Allsopp, 1952, 1953a, 1953b, 1953c, 1954, 1955), the taxonomic importance of such studies has gained world-wide significance. Linsbauer was probably

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the first to study the epidermal characters in *Lycopodium*. Porsch had suggested the phylogenetic importance of stomatal characters, Rehfous thought that the stomatal apparatus exhibits a constant feature within a group, and according to Miller (1938, p. 322) "the structure of the stomatal apparatus is markedly different in different groups of plants." Prat, after his comprehensive work on the epidermal structure of the Gramineae, stated that epidermal structures and their distribution of parts are specific characters. He says (1932, p. 185), "Correctement interpretés, les caractères épidermiques peuvent être de même valeur que les caractères qui ont servi de base à la définition des groupes systématiques." Satake (1934) has shown the systematic importance of the epidermal elements in the leaves of Japanese selaginellas and has founded a new classification on the basis of the epidermal structure of the leaves. Chowdhury (1937) studied the epidermis of eleven Indian species of *Lycopodium* and found that characters of the epidermis in most of the species were of diagnostic value. Some study has been made in my laboratory on the structure of the epidermis of some Indian species of *Selaginella*. As far as I know no detailed investigation on the epidermis of *Marsilea*, a plant with pronounced amphibious habit, has been undertaken in the past. The present examination, though brief, is clearly indicative of its usefulness.

The soral characters in the sporocarps of the genus have been studied in the past, but their systematic value had not yet been fully recognized.

SPECIMENS EXAMINED. The University of California material studied was collected by various workers over a period extending from 1849 to 1954. Except for *M. vestita*, which has a very wide distribution in the United States, all of the specimens examined are cited below:

MARSILEA VESTITA Hook. & Grev. UNITED STATES. Western Texas to El Paso, New Mexico, *Wright 811*, May-October 1849. UTAH. Rich County: Bear Lake near Laketown, *Porter 6490*, 30 June 1954. CALIFORNIA. San Diego County: *Purpus*, May-October 1898.

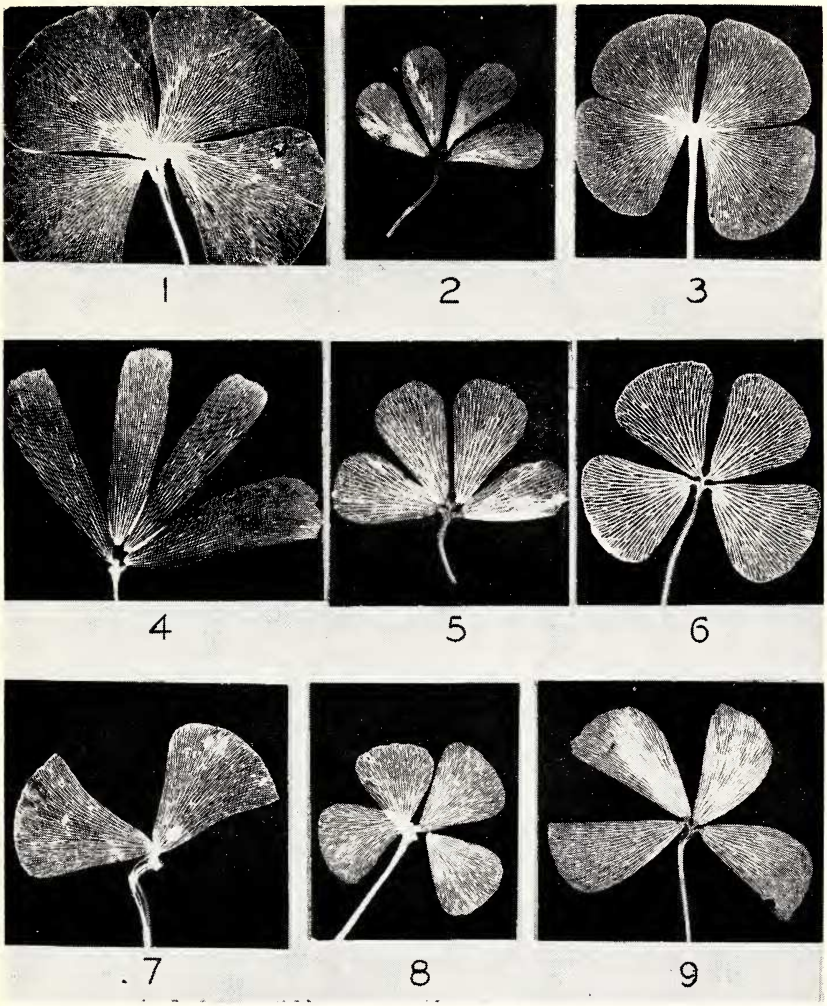
MARSILEA MOLLIS Rob. & Fern. MEXICO. CHIHUAHUA. St. Diego, *Hartman 604*, 20 April 1891. DURANGO. City of Durango and vicinity, *Palmer*, April-November 1896.

MARSILEA MEXICANA A. Br. MEXICO. CHIHUAHUA. Near Cusihuiriachic, *Pringle 2007*, 23 September 1888. SONORA. San Pedro, *Hartman 893*, 1894.

MARSILEA MACROPODA Engelm. MEXICO. TAMAULIPAS. Near Matamoras, *Pringle 1975*, 8 August 1888. UNITED STATES. TEXAS. (New Braunfels?), *Lindheimer 573*, 1846. Ponds on the Seco, *Reverchon 1630*, June, no year. Dimmit County: Turkey Creek south of Crystal City, *Muenscher* & *Winne 16506*, 29 June 1945. Jackson County: Lavaca River, *Tharp*, 29 August 1941.

MARSILEA FOURNIERI C. Chr. MEXICO. NUEVO LEON. Rio de San Juan outside of China, *Barkley 14344*, 27 February 1944. SONORA. Rancho San Carlos, 40 miles west of Hermosillo on road to Kino Bay, *Wiggins* & *Rollins 181*, 30 August 1941. BAJA CALIFORNIA. Seventeen miles south of Pozo Aleman, *Wiggins 7848*, 3 March 1935; 20 miles south of Calmalli, *Wiggins 5422*, 18 April 1931.

MARSILEA UNCINATA A. Br. UNITED STATES. Haven's Ranch, *Lemmon*, July 1882. TEXAS. Grown at Berlin Botanic Garden from fruit collected in Texas in 1872 by *E. Hall*. Comanche Spring, New Braunfels, *Lindheimer 1283*, June 1851. Caldwell County: dry sink, prairie, *Barkley 13130*, 7 July 1943.



FIGS. 1–9. Photographs of the quadrifoliate leaflets of *Marsilea* species, rendered transparent so as to show exact outlines and venation. 1, *M.* cf. *macropoda,* × 0.8; 2, *M. minuta,* × 1.3; 3, *M. mucronata,* × 1.3; 4, *M. tenuifolia,* × 1.3; 5, *M. mollis,* × 2; 6, *M. vestita,* × 1.3; 7, *M. uncinata* (lacking two leaflets), × 2; 8, *M. oligospora,* × 1.3; 9, *M. fournieri,* × 1.8.

MARSILEA TENUIFOLIA Engelm. UNITED STATES. TEXAS. Inks Lake, *Tharp,* 11 August 1941. (New Braunfels?), *Lindheimer 745* in 1847. Llano County: creek near Kingsland, *Whitehouse 18480,* 4 May 1947; creek bed, *Tharp,* 15 August 1940.

MARSILEA OLIGOSPORA Goodd. UNITED STATES. WYOMING. Uinta County: Jackson Lake, *Nelson 6560,* 12 August 1899 (isotype). Elmore County: King Hill, *Nelson* & *Macbride 1158,* 17 July 1911. Sublette County: near New Fork Lake, *Payson* & *Payson 4437,* 24 July 1925; Kendall, *Payson* & *Payson 2920,* 5 August 1922.

MARSILEA MUCRONATA A. Br. UNITED STATES. NORTH DAKOTA. Valley City, *Stevens 1223,* 1 August 1950. Benson County: Butte, *Lunell,* 5 September 1905. Nebraska. Exeter, *Wibbe,* September 1888. Wyoming. String Lake, *Prettyman,* 20 July 1953.

Marsilea quadrifolia L. UNITED STATES. Connecticut. New Haven, *Setchell,* 3 October 1883. Cromwell, *Hubbard 6817,* no date. Litchfield County: Bantam Lake, *Bridgman,* 1888, *Thompson,* August 1891. Massachusetts. Falmouth, *Brooks,* 30 August 1910. Salem, *Harper* & *Harper,* 19 July 1895. Glacialis Pond, Cambridge, *Pease 5672,* 9 October 1904. Norfolk County: Wellesley, *Brown,* 14 August 1940. Kentucky. Fayette County: two miles east of Lexington, *McFarland 46,* 25 September 1940.

Marsilea minuta L. MEXICO. Coahuila. Cerro de Cypriano, *Purpus 4525,* July 1910. Sinaloa. Culiacan, *Brandegee,* 11 November 1904. Baja California. San Jose del Cabo, *Brandegee,* September 1893, 16 October 1899, 25 October 1902. Jalisco. Near Guadalajara, *Pringle 2434,* 6 December 1889.

Marsilea cf. macropoda Engelm. MEXICO. Coahuila. Rancho Agua Bueno, 43 miles north of Monclova, *Gould 6405,* 20 June 1952.

In studying the above-cited specimens, the vegetative and reproductive structures were prepared in the following manner.

Hairs. The hairs from different regions (leaves, nodes, and the sporocarps) were removed dry and mounted directly in liquid paraffin on a clean slide in the manner usually employed for the examination of fibers of wool or cotton, so as to bring out their medullated or non-medullated nature quite distinctly.

Epidermis. For studying the epidermal structures, the leaves were treated with dilute KOH solution, washed in water, carefully teased, and stained with a single stain, safranin. After usual dehydration they were mounted in Canada balsam for examination.

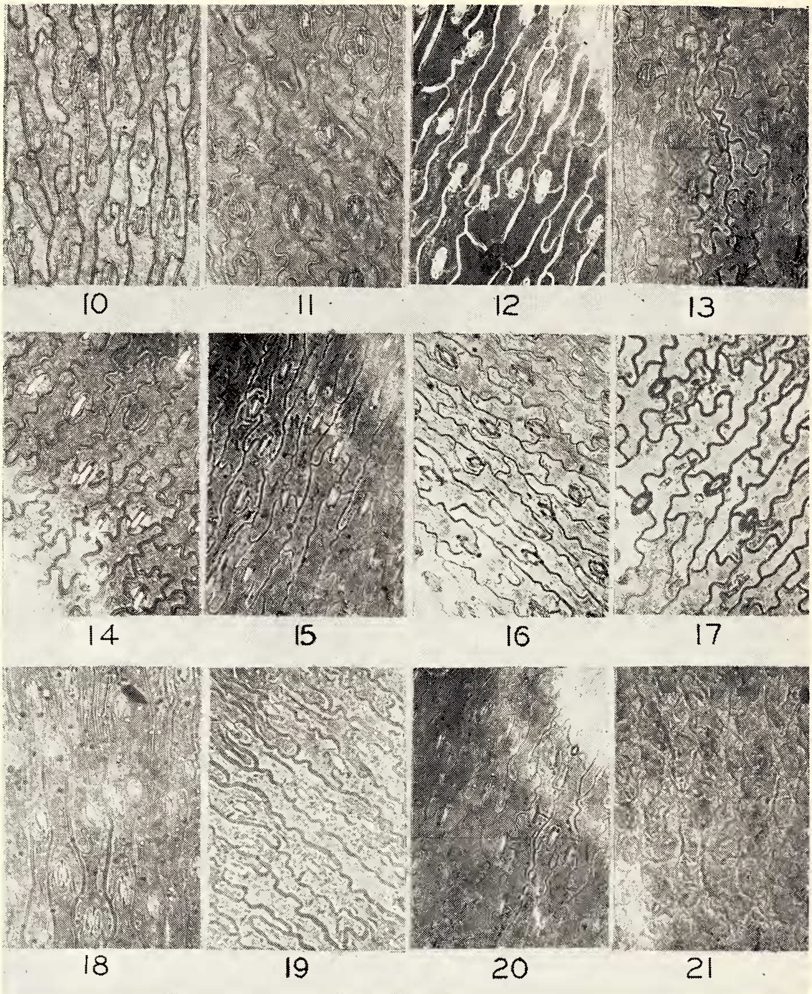
Sporocarps. The sporocarps were examined dry for their external features, but in order to ascertain their soral number, they were soaked in warm water after slightly scratching their resistant walls with a knife. This facilitated the so-called germination. The coming out of the mucilaginous mass is a mechanical process and cannot be strictly described as germination, as people often believe, because the real germination would mean the future activity of the mega- and microspores leading to the production of the gametophytes. The sporocarps were dissected further to study the nature of the sorus, the structure of the mega- and microsporangia, and also to find out whether the sporocarps were normal or possessed abnormalities which are often of a fluctuating type.

Range of Variation

The habitats of *Marsilea* vary from aquatic to subterrestrial or terrestrial; almost all species start as aquatic plants during which time their vegetative growth is pronounced. Some, like *M. minuta,* also produce sporocarps in the aquatic habitat, while others, like *M. aegyptiaca,* never do so. The majority of the species possess the tendency to fruit only under a subterrestrial habitat, and in fact most of the specimens from the University of California Herbarium seem to have been collected under subterrestrial conditions. They grow in plains (100 feet above sea level) as

TABLE 1. VEGETATIVE CHARACTERS OF THE NORTH AMERICAN SPECIES OF MARSILEA

General							Hairs			Epidermis		
Name of species	Habit	Length of petiole			Shape of leaflets	A/B Leaflet ratio	Average length in mm. and number of cells			Stomatal frequency	Size of stomata	Wall of epidermal cells
		Min.	Max.	Ave.			nodes	leaves	sporocarps			
M. vestita	Aquatic, sub-terrestrial and terrestrial	1.5	5.5	3.4	Obovate	0.33 : 0.29	1.7; 7	1.4; 4	1.4; 7	22	0.02 x 0.01	Long, somewhat straight
M. mollis	Not mentioned	0.5	1.1	0.84	Cuneate	0.18 : 0.08	-	1.0; 4	1.8; 5	10	0.03 x 0.02	Highly wavy
M. mexicana	Subterrestrial	5.0	6.3	5.6	Cuneate	0.33 : 0.32	-	-	-	8	0.02 x 0.01	Less wavy
M. macropoda	Aquatic and subterrestrial	1.4	8.3	4.5	Obovate	0.39 : 0.35	1.3; 9	1.9; 6	2.0; 9	9	0.03 x 0.01	Long and smooth
M. fournieri	Subterrestrial and terrestrial	1.0	2.4	2.69	Obovate	0.2 : 0.14	2.9; 8	1.6; 5	1.3; 6	17	0.02 x 0.02	Long, narrow,wavy
M. uncinata	Terrestrial	1.1	3.0	2.45	Cuneate	0.24 : 0.22	1.7; 7	0.5; 3	0.5; 5	13	0.02 x 0.01	Wavy
M. tenuifolia	Aquatic	2.5	6.3	3.79	Oblanceolate	0.94 : 0.4	1.5; 10	0.6; 3	1.0; 5	6	0.03 x 0.01	Straight
M. oligospora	Aquatic and terrestrial	0.4	2.2	1.3	Obovate	0.24 : 0.18	1.8; 8	1.1; 4	1.2; 6	6	0.02 x 0.01	Wavy
M. mucronata	Terrestrial	1.2	4.5	2.91	Cuneate	0.31 : 0.23	0.3; 7	0.5; 3	0.5; 3	5	0.03 x 0.02	Wavy
M. quadrifolia	Aquatic, sub-terrestrial and terrestrial	2.6	11.1	4.34	Obovate	0.45 : 0.41	1.5; 6		1.8; 6	5	0.02 x 0.01	Straight
M. minuta	Subterrestrial	1.5	6.0	3.4	Cuneate	0.29 : 0.18	1.16; 7	0.9; 4	-	17	0.02 x 0.01	Wavy
M. cf. macropoda	Subterrestrial	10.6	14.0	12.6	Fan-shaped	1.04 : 1.11	1.3; 8	2.0; 6	1.6; 6	8	0.02 x 0.01	Wavy



FIGS. 10–21. Photomicrographs of the epidermis of American Marsileas, showing nature of the epidermal cells and distribution of stomata. 10, *M. vestita*; 11, *M. oligospora*; 12, *M. macropoda*; 13, *M.* cf. *macropoda*; 14, *M. mollis*; 15, *M. mexicana*; 16, *M. fournieri*; 17, *M. uncinata*; 18, *M. tenuifolia*; 19, *M. minuta*; 20, *M. mucronata*; 21, *M. quadrifolia*. All about × 85.

well as on mountains, 6000 feet or above. Not only this, but some species like *M. vestita* are found in the plains (160 feet above sea level) as well as in the higher altitudes (5800 feet), whereas a species like *M. mollis* is confined to higher levels (6000 feet) only.

The rhizome is creeping and branches dichotomously. The internodes are short or long, sometimes becoming very much reduced. The adventitious roots, few or more in number in different species (one to eight), usually arise ventrally from the nodes of the rhizome. The size of the petiole varies considerably (from one to nine inches in length in different species), and so also the shape and size of the leaflets. The oblanceolate leaflets of *M. tenuifolia* (fig. 4) are quite peculiar to the species (Table 1).

The detailed examination of the structure of the hairs revealed the differences that exist among them in the different organs in the same species or on the same organs of the different species. The main point of interest is centered around the shape and size of either the basal or the terminal cells of the hairs of these organs (Table 1).

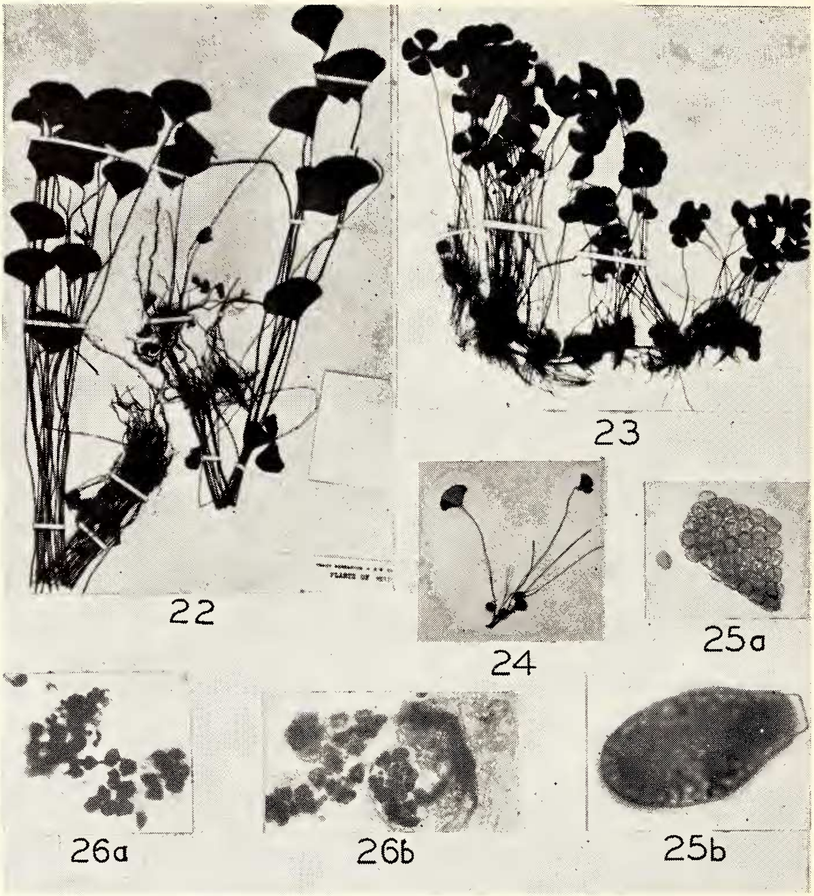
The study of epidermal structures has revealed that the species seem to differ from one another at least in two important respects, namely nature of the epidermal cells and the frequency of the stomatal distribution. The walls of the epidermal cells are either smooth, slightly wavy, or highly so, and the frequency of the stomata per unit area ranges from five to twenty (Table 1).

The sporocarps are stalked. Their attachment to the petiole is either basal or adnate, and the number of the sporocarps in a group may be one or more, connate or free (figs. 27–38). The shape differs from species to species, for instance it is subspherical in *M. minuta* (fig. 37), oval in *M. mollis* (fig. 28) and clearly bean-shaped in *M. vestita* (fig. 27). All the American species possess two horns, these varying in their prominence and bluntness. Similarly there is a difference in their soral number, a fact that seems to be of some systematic importance in the genus *Marsilea*.

Discussion of the Species

Marsilea vestita and M. oligospora. *Marsilea vestita* is very well represented in the collection by 84 sheets which date from 1894 to 1954. While the general characters are given in tables 1 and 2, I should like to mention a few interesting observations on this species. The anatomy of the epidermis shows that the walls of the epidermal cells are long and more or less straight (fig. 10). The stomata are uniformly distributed throughout, their orientation being in the direction of the length of the epidermal cells. The frequency of the stomatal distribution is almost the highest among the species here examined, namely twenty-two per unit area.

There is a single stalked sporocarp in *M. vestita* which is attached at the base of the petiole. It is bean-shaped and possesses both the horns, the upper pointed and the lower one blunt (fig. 27). An abnormal specimen with a sporocarp adnate to the petiole was found on sheet UC 205105 (fig. 24). Most of the specimens possessed normal sporocarps with normal type of both mega- and microspores (figs. 25a, 25b), but a critical search of the specimens revealed the presence of abnormal sporocarps (fig. 26a). The latter had no megaspores but only microspores. Sometimes these microspores were also of two types (fig. 26b). As pointed out in the



FIGS. 22–26. FIG. 22, *M.* cf. *macropoda,* habit showing largest leaflets and petioles, ca. × 0.25. FIG. 23, *M. macropoda,* same for comparison, ca. × 0.25. FIG. 24, *M. vestita,* abnormal specimen found on UC 205105, sporocarp adnate to petiole, × 0.25. FIG. 25, *M. vestita,* megaspores (25b) and microspores (25a) from a normal sporocarp, × 25. FIG. 26, *M. vestita,* microspores from two different sporocarps (26a, abnormal; 26b, normal), × 25. Generally in abnormal sporocarps megaspores are absent.

introduction, such a thing was expected in a species with a wide distribution; however, the significance of these and such other abnormal sporocarps as have been discovered in more than one Indian species is not discussed here.

It is important to point out that Miss Stason's observation (1926, p. 478) that *M. oligospora* may be an "ecotype" of *M. vestita* may not be quite correct, for I find that the epidermal as well as soral characters are distinct in the two species (figs. 10, 11, 27, 34) insofar as they are represented in the collection studied. For these reasons I prefer to regard *M. oligospora* as a distinct species rather than just an ecotype of *M. vestita.*

Marsilea macropoda and M. cf. macropoda. Five sheets in the series studied represent *M. macropoda* (fig. 23) and one specimen is questionably referred to that taxon as *M.* cf. *macropoda* (fig. 22). At the outset I should like to mention that these two look quite distinct from one another. The latter possesses not only larger leaves and sporocarps than *M. macropoda,* but probably larger than any species (figs. 1–9) represented in the series here treated. The epidermal cells in *M. macropoda* possess long and smooth walls (fig. 12), whereas in *M.* cf. *macropoda* the epidermal cells possess wavy cell walls (fig. 13) with stomatal frequency, however, being nearly the same in the two cases, namely nine and eight, respectively.

The sporocarps are stalked and tufted at the base of the petiole in *M. macropoda* (fig. 30). They are oval in shape and the biggest in size as compared with other species. On the other hand a group of only two or three sporocarps which are slightly adnate to the petiole is found in the specimens of *M.* cf. *macropoda* (fig. 38). The sporocarps in the two cases are, however, densely covered with hairs and possess both the horns, the lower one being more prominent.

One of the petioles in *M. macropoda* bears five leaflets instead of the usual four. This is not a very unusual feature in Marsileas, having been described for *M. quadrifolia* in 1948 and *M. aegyptiaca* in 1956.

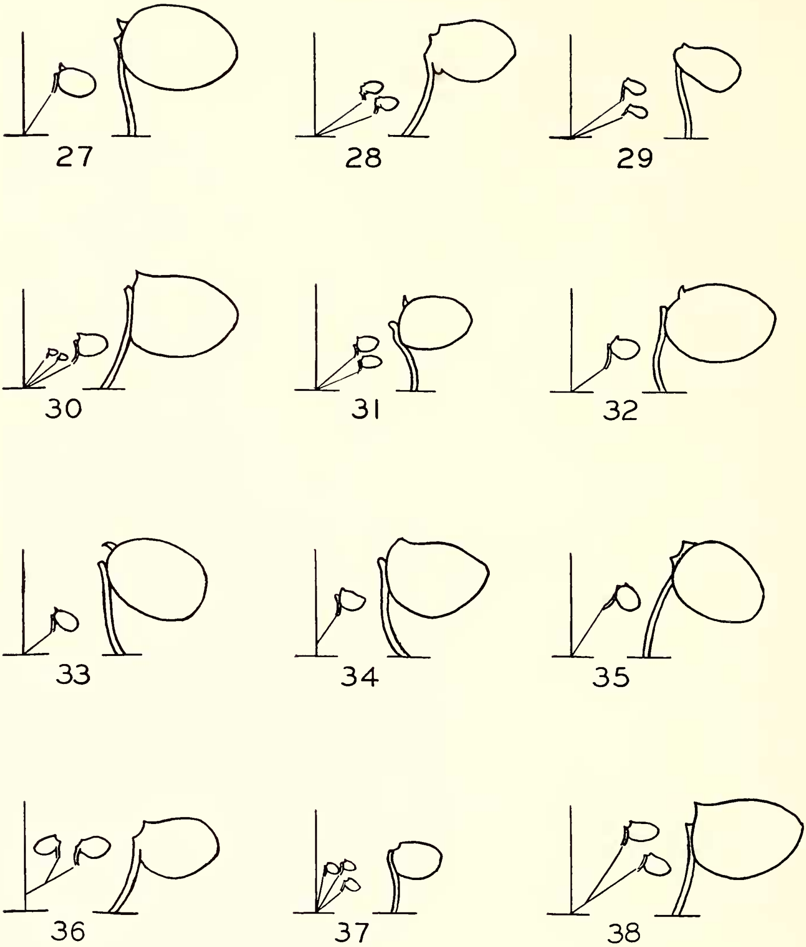
Marsilea mollis. There is only one herbarium sheet of this species, containing plants collected at two different times (1891 and 1896). The habit of this species is quite characteristic, with small hairy leaflets. There are no rhizomes or roots preserved; perhaps these are very much reduced. The epidermal cells of the leaves show wavy nature in their walls (fig. 14) and the uniformly distributed stomata show a frequency of about ten stomata per unit area.

The stalked sporocarps are tufted in nature, and their exact mode of attachment is not possible to describe in the absence of the rhizomes. The hairy and ribbed sporocarps are more or less oval in shape and possess two blunt horns (fig. 28). The soral number is about 15 in the species.

Marsilea mexicana. The two herbarium sheets of this species (collected in 1888 and 1894) are badly preserved. The leaves show epidermal cells which are less wavy and possess stomatal frequency of only eight per unit area (fig. 15).

The sporocarps are a bit characteristic in being somewhat narrower on the sides and swollen in the middle (fig. 29). They are ribbed and possess two blunt horns, with soral number twelve.

Marsilea fournieri. The four herbarium sheets contain material from both subterrestrial and terrestrial habitats. The leaves are obovate. The epidermal cells are long and narrow with their walls wavy in nature (fig. 16). The stomatal frequency is quite high, as much as 17 per unit area.



Figs. 27–38. Outline diagrams showing attachment of sporocarps to the petiole and the peduncles as well as the shape of the individual sporocarps. 27, *M. vestita*; 28, *M. mollis*; 29, *M. mexicana*; 30, *M. macropoda*; 31, *M. fournieri*; 32, *M. uncinata*; 33, *M. tenuifolia*; 34, *M. oligospora*; 35, *M. mucronata*; 36, *M. quadrifolia*; 37, *M. minuta*; 38, *M.* cf. *macropoda*. All about × 30.

The stalked sporocarps remain tufted at the base of the petiole. They are clearly bean-shaped and possess both the horns, which are pointed. The upper horn is further characterized by being longer and curved (fig. 31). The ripe mature sporocarps are quite smooth and ribbed, otherwise the species, like *M. macropoda,* is profusely covered with hairs.

Marsilea uncinata. In the four herbarium sheets the vegetative characters are quite variable, as for instance the number of roots (2 to 8) on the nodes and the size of the internodes. The leaves are cuneate, possessing epidermal cells with wavy walls (fig. 17). The stomatal frequency is thirteen per unit area.

There is a single stalked sporocarp which is oval in shape and is attached almost at the base of the petiole. There are two horns present on the sporocarp, the upper one being pointed and curved (fig. 32). The pedicel is fully adnate to the body of the sporocarp, which is smooth and possesses 16–18 sori.

Marsilea tenuifolia. The four herbarium sheets all contain material collected in an aquatic habitat. The leaves are very characteristic of the species, being oblanceolate in shape (fig. 4). The anatomy of the epidermis shows that the epidermal cells are long and narrow. The walls of the epidermal cells are smooth (fig. 18). The distance between the two walls of the same epidermal cell is narrow in the non-stomatal region and increases in the stomatal region as if to house the stomata. The frequency of stomatal distribution is 6 per unit area.

The single bean-shaped sporocarp is attached by a short stalk at the base of the petiole. There are two horns present; the upper one is pointed and curved downwards (fig. 33); the wall of the sporocarp is smooth and not hairy. It may be noted that there were only two sporocarps present on one specimen, while other plants were sterile.

Marsilea mucronata. The four herbarium sheets were all collected from a terrestrial habitat. The leaflets are cuneate in shape. The anatomy shows epidermal cells with wavy cell walls (fig. 20). The frequency of stomatal distribution is lowest in this species, being only five per unit area.

The sporocarps are usually solitary, rarely two arising from the base of the petiole. They are bean-shaped with the pedicels partially adnate to the sporocarps (fig. 35). There are two horns; both are pointed. The soral number is 16.

Marsilea minuta and M. quadrifolia. Both these species are found widely distributed in India and are the common ones that have been described previously in and outside India (Pande, 1923; Mahabale & Gorji, 1948; Mehra, 1938; Puri & Garg, 1953; and Williams, 1920). And as a further study of the Indian species is in hand, it is not profitable to deal with them here, particularly in view of the fact that the University of California specimens did not contain enough material of well preserved nature.

The epidermal studies (figs. 19, 21) in both the species have revealed that the stomatal frequencies in these are different, being five in *M. quadrifolia* and seventeen in *M. minuta*. Similarly the attachment of the sporocarp is characteristic in *M. quadrifolia,* being adnate to the petiole and connate to the pedicel (fig. 36), while in *M. minuta* two to six sporocarps are slightly connate at the base of the petiole (fig. 37). The comparison with the Indian material available in my laboratory indicated minor differences, but, in view of wide distribution of these species, these minor differences are natural.

Conclusion

From the foregoing brief description of eleven American species of *Marsilea,* it is apparent that the genus exhibits clear variations in the vegetative as well as in the reproductive organs, namely the sporocarps. In spite of a similar habitat, whether aquatic, subterrestrial or terrestrial, species do differ from one another, say for instance in the shape and size of their leaves (figs. 1–9) and structures of their sporocarps (figs. 27–38). The other types of variations that are often present in the same species under varied environmental conditions are distinctly different from the former differences, and are always exhibited within certain limits in that species. The latter should not be confused with the former. A thorough ecological study, therefore, becomes imperative, besides other important considerations of anatomy and cytology, not only to decide clearly the differences between two species but also to find out the range of variations within the species. Such an autecological aspect is being attempted with *M. aegyptiaca* here in the Botany Department at Jaswant College.

One simple aspect of morphology, namely the examination of the epidermis of the leaflets of these eleven species of *Marsilea,* has demonstrated how the structure of the walls of the epidermal cells and the frequency of stomatal distribution can be of some diagnostic value. It has been possible to indicate in the present thesis, for instance, that the species pairs *M. vestita–M. oligospora* and *M. macropoda–M.* cf. *macropoda* are quite distinct. If only the two above characters of the epidermis are taken into consideration, the present collection can be arranged into three different categories, namely, those with wavy walls, those with less wavy walls and those with smooth walls.

The structure and attachment of the sporocarps, however, provide the main clue to the correct identification of the species. The main features that are useful and essential for systematic considerations have been mentioned in Table 2. For the present, however, the number of sporocarps in a group and the nature of attachment of these sporocarps to the petiole have been adopted as a broad basis for classification (Gupta & Bhardwaja, 1956). Accordingly these American species can be arranged as follows:

Pedicel adnate

M. macropoda
M. quadrifolia
M. oligospora

Pedicel basal

Sporocarps more than one, connate or free

M. mexicana
M. minuta
M. mollis
M. fournieri

Sporocarp solitary

M. vestita
M. uncinata
M. tenuifolia
M. mucronata

It must, however, be admitted that the systematics of the genus *Marsilea* is a neglected subject, and it is hoped that as a result of detailed

TABLE 2. MORPHOLOGICAL CHARACTERS OF THE SPOROCARPS IN THE AMERICAN SPECIES OF MARSILEA

	External						Internal		
Name of species	Disposition	Relation of pedicel to petiole	Relation of pedicel to pedicel	Shape and size	Attachment of pedicel to sporocarp	Nature and number of horns	Soral number	Megasporangia and spores	Microsporangia and spores
M. vestita	Solitary	At the base	Free	0.18 Bean-shaped	Fully adnate	2, upper horn pointed	18	Normal or absent	Normal or abnormal
M. mollis	Tufted (?)	At the base	Not seen	0.11 Oval-shaped	Partially adnate	2, blunt	14-15	Normal	Normal
M. mexicana	Tufted	At the base	Partially connate, free (?)	0.11	Partially adnate	2, blunt	12	Normal	Normal
M. macropoda	Tufted	Slightly adnate at the base	Slightly connate at the base	0.25 Oval-shaped	Fully adnate	2, lower prominent	20	Normal	Normal
M. fournieri	Tufted (?)	At the base	Slightly connate at the base	0.11 Bean-shaped	Fully adnate	2, both pointed upper one slightly curved towards right	17	Normal	Normal
M. uncinata	Solitary	At the base	Free	0.13 Oval-shaped	Partially adnate	2, upper more pointed and more curved towards right	16-18	Normal	Normal
M. tenuifolia	Solitary	At the base	Free	0.13 Bean-shaped	Fully adnate	2, same as above	-	Normal	Normal
M. oligospora	Solitary rarely two	Slightly adnate at the base	Free	0.16 Oval-shaped	Partially adnate	2, lower more prominent, upper obscure	14	Normal	Normal
M. mucronata	Solitary rarely two	At the base	Free	0.2 Oval-shaped	Partially adnate	2, both pointed	16	Normal	Normal
M. quadrifolia	2, 3	Adnate	Connate	0.14 Oval-shaped	Fully adnate	2	16-20	Normal	Normal
M. minuta	2, 3	At the base	Free	0.11 Subspherical	Fully adnate	2	13	Normal	Normal
M. cf. macropoda	2, 3	Slightly adnate	Connate	0.21 Oval-shaped	Fully adnate	2, lower prominent			

investigation that is proceeding in the Botany Department at Jaswant College, some useful light will be thrown on the problem. Ecological, morphological and cytological studies of some Indian species seem to indicate a very promising field, and it may be possible in the near future to throw light on the nature of various so-called "ecotypes" possessing fertile or fluctuating type of sterile sporocarps, as a matter of fact, on the entire phenomenon of speciation in the genus *Marsilea*.

Summary

Herbarium specimens representing eleven different species of *Marsilea* from North America have been examined, and in each case the structure of the epidermis and the sporocarps has been described. It has been shown that the species differ from each other in nature of their epidermal cells and the distribution of their stomata. So also they differ in external and internal characters of their sporocarps. The more important characters of the latter, as well as vegetative features in all these species, have been tabulated; in addition, the anatomical features of the leaves have been given in a series of photographs to indicate clearly that vegetative features, both external and internal, do contribute minor, if not major, criteria in identification of the various species of *Marsilea*.

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